Feed versus fuel: the effect of future animal production on biomass potential and prices

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Publication date:
2014

Baseline

Uses default assumptions for population (9 billion by 2060) economic growth (2100 global GDP = 9 x 2005 global GDP), crop yield improvement (FAO projections), and energy consumption

Plant-based

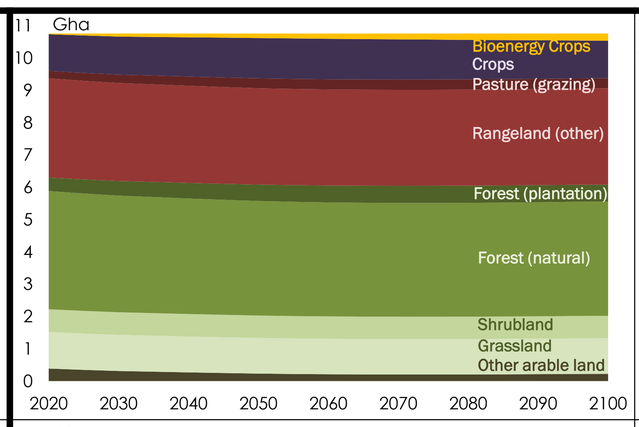
Baseline assumptions kept, but global diet is changed and there is minimal consumption of animal food products. Vegetal food consumption increases correspondingly.

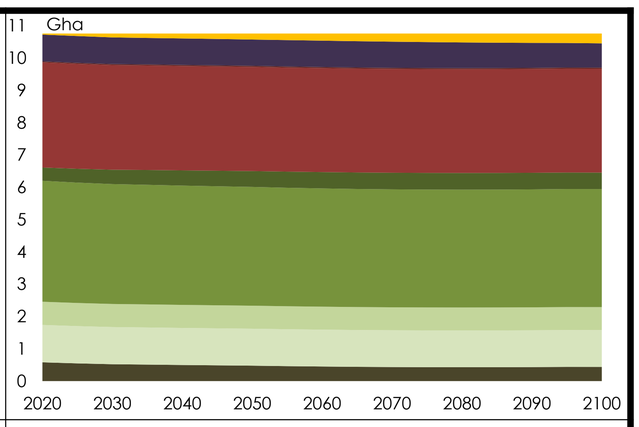
No CAFO

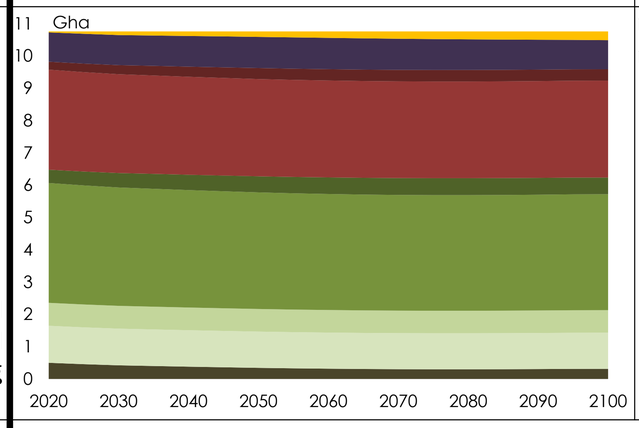
Baseline assumptions kept, except feed crops are removed. All animals are fed by grazing, scavenging, or residue fodder.

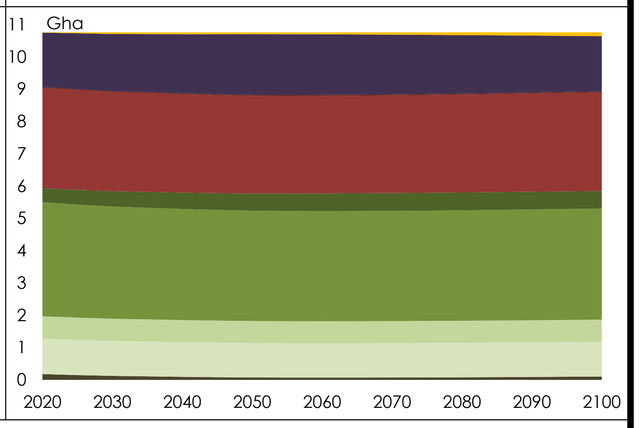
All CAFO

Baseline assumptions kept, except pasture grazing and scavenging are removed. All animals are produced industrially: crop-fed on concentrated animal feeding operations (CAFOs).

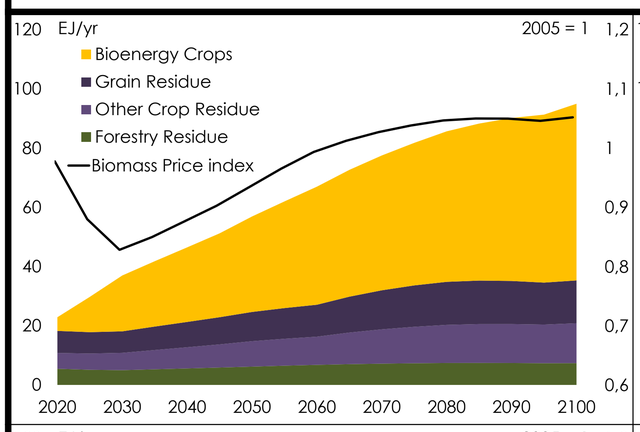


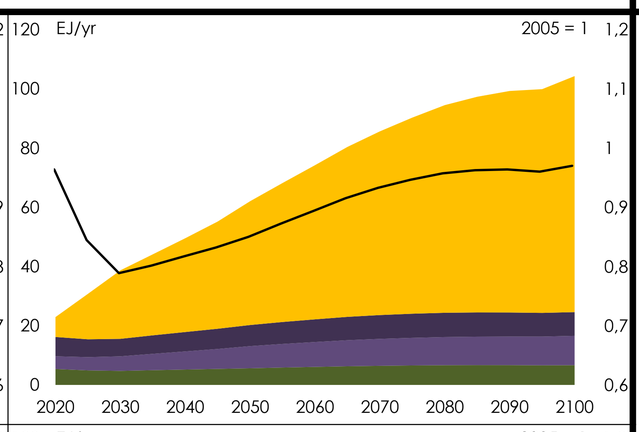


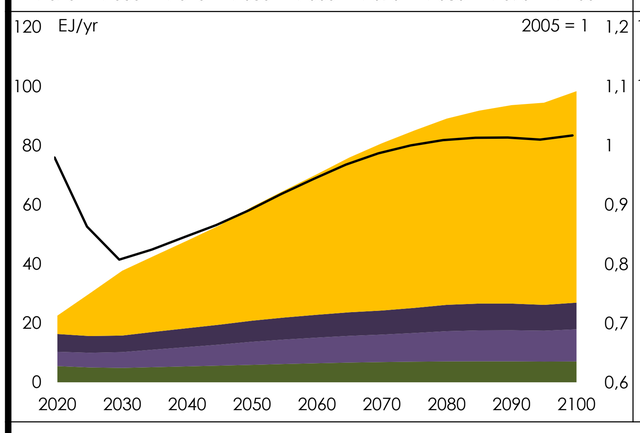


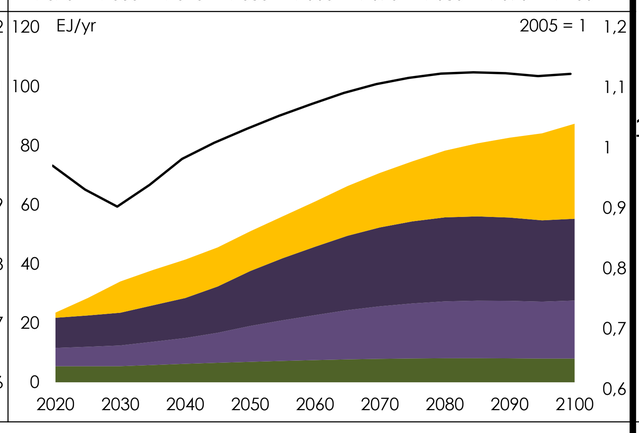


Scenarios



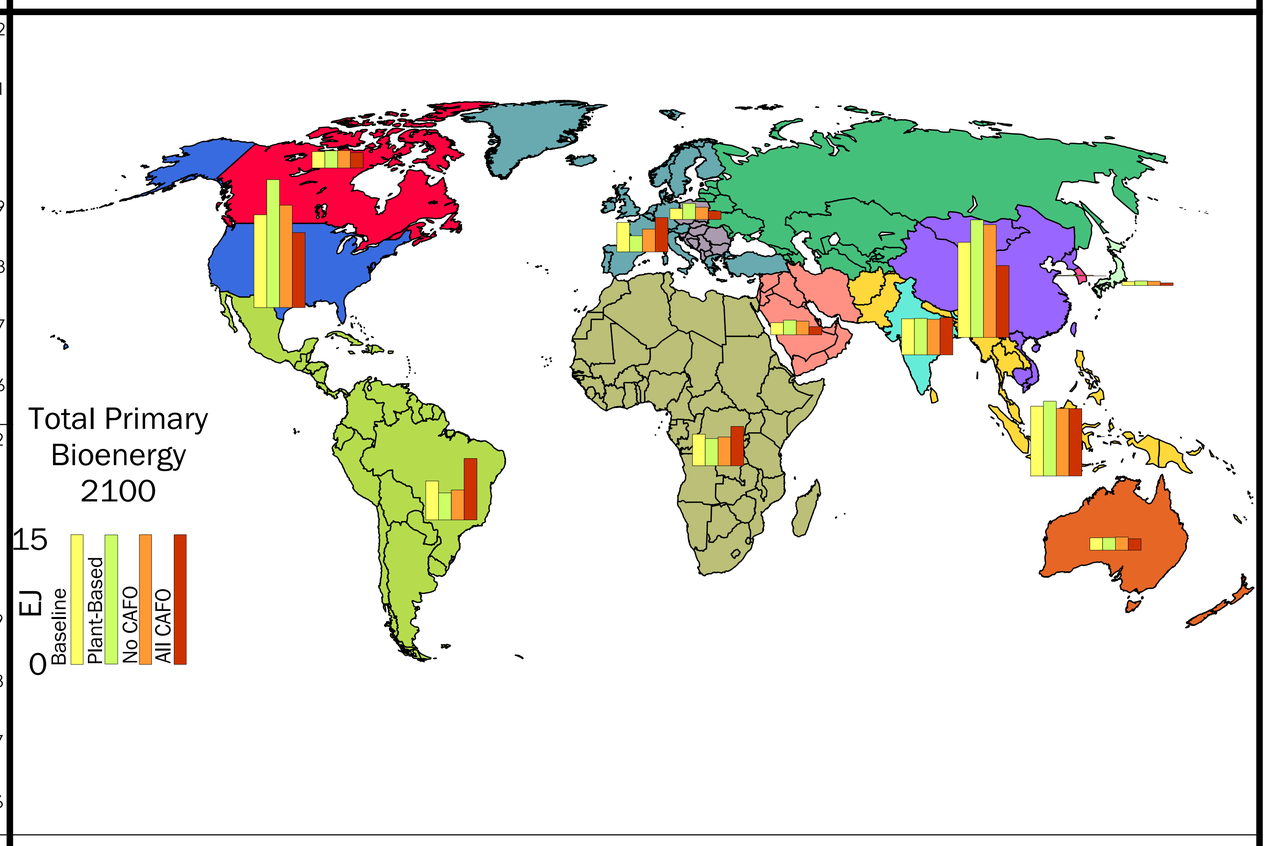






Bioenergy Production and Prices

Global Land Use



Spatial Distribution

Animal production systems occupy 30% of the Earth's land, and 70% of the world's agricultural land (FAO, 2006). Dornburg et al. (2010) identify dietary choices (and its corresponding effect on land use) as one of the most important parameters in determining future potential for bioenergy. Globally, there is currently a 10-fold disparity in meat intake between the highest and lowest consuming population groups (mean at 100 g/person/day) (McMichael et al, 2007), with demand increasing in transition economies. This study examines the trade-offs between land use for animal feed production versus biomass for bioenergy production in terms of economic potential and bioenergy price indices.

Introduction

Multiple scenarios for how animals are fed are simulated in the Global Change Assessment Model (GCAM), a partial equilibrium energy-economic-environment integrated assessment model (Wise & Calvin, 2011). GCAM runs through the year 2100 in 5-year time steps. It includes an integrated land use model, based on the 18 Agro-ecological zones, intersected with 14 geo-political economic regions, creating 151 sub-regions. Land use competition is based on economic optimization for potential uses of a given sub-region based on its ecological potential. Dietary demand for animal products is kept constant across all scenarios, except the plant-based diet scenario. Demand and production of non-food animal goods (e.g., wool, leather, etc.) is kept constant across all scenarios.

Methodology

Reducing animal product demand results in a reduction of bioenergy prices and increases the economic potential for bioenergy in the future, with a greater share of the biomass portfolio coming from dedicated bioenergy crops versus crop residues. On the other hand, relying on industrialized animal production requires substantial amounts of high-quality cropland to grow feed crops. This leaves little land left for bioenergy, though more residue biomass becomes available. Pasture grazing of animals creates less competition, as this land has lower potential for growing crops. Geographically, reduction of CAFOs creates more opportunity in US and China to produce biomass crops, as it frees up cropland used for feed crops. Increased development of CAFOs moves biomass production to South America, Africa and Western Europe, where pasture grazing is freed up to grow bioenergy crops. Bioenergy and feed are intricately linked, as they compete for the same resources. This has particular implications for the developing regions of the world and sustainable development: animal product demand is expected to continue to increase (and intensify with modern production systems) creating tight competition for land dedicated to bioenergy production.

Results & Conclusions

Dornburg, V., Vuuren, D. v., Ven, G. v. d., Langeveld, H., Meeusen, M., Banse, M., Faaij, A. (2010). Bioenergy revisited: Key factors in global potentials of bioenergy. Energy & Environmental Science, 3, 258-267.
Food and Agriculture Organisation of the United Nations. 2006. Livestock's Long Shadow – Environmental Issues and Options. Rome.
McMichael, AJ, John W Powles, JW, Butler, CD, Uauy, R. 2007. Food, livestock production, energy, climate change, and health. Lancet 370: 1253–63
Wise, M., & Calvin, K. (2011). GCAM 3.0 Agriculture and Land Use: Technical Description of Modeling Approach: US Department of Energy, Pacific Northwest National Laboratory.

How does animal production affect the biomass market?

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